



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND
POLLUTION PREVENTION

MEMORANDUM

Date: September 25, 2013

SUBJECT: Naphthalene: Data Evaluation Record for the Study "A 180-Day Indoor Air Monitoring Study Estimating Naphthalene Levels in Air Following Residential Application of an EPA-Registered Naphthalene Mothball Product"

PC Code: 055801

MRID No.: 48740601

Petition No.: NA

Assessment Type: Data Evaluation
Record

TXR No.: NA

DP Barcode: D401780

Registration No.: NA

Regulatory Action: Risk Assessment

Reregistration Case No.: NA

CAS No.: 556-61-6

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This document serves as a data evaluation record for the naphthalene mothball long-term indoor air monitoring study, "A 180-Day Indoor Air Monitoring Study Estimating Naphthalene Levels in Air Following Residential Application of an EPA-Registered Naphthalene Mothball Product (MRID 48740601)," submitted by Recochem, Inc. The study was conducted to measure the airborne concentrations of naphthalene over a long-term (180 day) exposure duration following

treatment with naphthalene mothballs. A primary review of this study was conducted by Versar, Inc. under the guidance of HED.

STUDY TYPE: Ambient Indoor Air Monitoring for Residential Application of Mothballs

TEST MATERIAL: ENOZ[®] Old Fashioned Moth Balls, containing 99.95% of the active ingredient (ai) naphthalene.

SYNONYMS: Naphthalene; CAS No. 556-61-6.

CITATION:

Research Director:	Layla E. Crawford, Ph.D.
Title:	<i>A 180-Day Indoor Air Monitoring Study Estimating Naphthalene Levels in Air Following Residential Application of an EPA-Registered Naphthalene Mothball Product</i>
Report Date:	February 8, 2012
Analytical Laboratory:	Landis International, Inc. P.O. Box 5126 3185 Madison Highway Valdosta, GA 31603-5126 USA
Field Laboratory:	Wildlife International, Ltd. 8598 Commerce Drive Easton, MD 21601 USA
Identifying Codes:	Landis Protocol No. 29821A003; Wildlife International, Ltd. 190C-108; MRID # 48740601; Unpublished

SPONSOR: Recochem, Inc.
850 Montee de Liesse Road
Montreal, Quebec
Canada H4T

EXECUTIVE SUMMARY:

This study was designed to determine the levels of naphthalene in the indoor air resulting from the use of the product ENOZ[®] Old Fashioned Moth Balls, containing a nominal 99.95% of the active ingredient naphthalene. The study was conducted at two uninhabited residences in Georgia (one control and one treated) in 2011. In the bedroom of the treated house, the test product was placed inside an open container in a closet and also in an empty dresser drawer. The product was applied at the maximum label rate of 1

oz/3 ft³, therefore, 62.24 oz (1764.5 g) was applied to the closet and 0.41 oz (11.6 g) was applied to the dresser drawer.

Air monitoring was performed in both the untreated and treated residence using Chromosorb 106 sorbent tubes attached to an Air Check 2000 air sampler (SKC, Inc.) with a constant air flow of 0.2 L/min. Seven 15-minute samples were collected at the following intervals: 1 hr prior to application and at 1, 4, 8, 12, 16, and 24 hours after application. Thirty-seven 8-hour samples were collected at the following intervals: daily between Day 2 and Day 14 after application and once weekly thereafter over the 182 day study period. One sampling location was used in the untreated house (on the bed) and three sampling locations were used in the treated house (Zone 1 - outside the closet; Zone 2 - on the dresser; and Zone 3 - on the bed).

The Registrant reported air concentrations in mg/m³, as well as exposure concentrations in mg/hr, adjusted for human respiration. Versar calculated corrected air concentrations in mg/m³ using the average recovery from the low level field fortification, which was the level that most closely corresponded to the field residues. In all calculations Versar used ½ limit of detection (LOD) or ½ limit of quantitation (LOQ) if the concentration was below the LOD or between the LOD and LOQ, respectively. The LOQ, defined as the lower limit of method validation (LLMV), was 1.50 µg, which is equivalent to 0.500 mg/m³ for a 15-min exposure and 0.0156 mg/m³ for an 8-hr exposure at an airflow rate of 0.2 L/min. The LOD was 0.207 µg, which is equivalent to 0.0217 mg/m³ for a 15-min exposure and 0.00215 mg/m³ for an 8-hour exposure at an airflow rate of 0.2 L/min.

In the non-treated residence, naphthalene residues were <LOD in all 15-min samples collected from the bed and <LOD or <LOQ from all 8-hr samples collected from the bed.

For the treated residence, all residues were <LOQ or <LOD in the 15-min samples collected over six intervals from 1 hour to 24 hours after application. For the 8-hr samples collected 2 days through 182 after application, naphthalene air concentrations ranged from 0.0011 (<LOD) to 0.0574 mg/m³ (average of 0.0369 mg/m³) in all Zones. Specifically, air concentrations were 0.0011 (<LOD) to 0.0471 mg/m³ (average of 0.0360 mg/m³) in Zone 1 (outside closet door), 0.0078 (<LOQ) to 0.0574 mg/m³ (average of 0.0386 mg/m³) in Zone 2 (on top of the dresser), and 0.0210 to 0.0459 mg/m³ (average of 0.0362 mg/m³) in Zone 3 (on the bed). In general, residues stabilized within 2 days after the application and remained relatively stable throughout the monitoring period. The study author conducted regression analyses which showed significant positive correlation between time and naphthalene concentration in Zones 1 and 3. In Zone 2, this correlation was not observed, but according to the study author a small correlation could have been masked by sample variability. The study author also conducted analysis of variance (ANOVA) testing which indicated that there were no significant differences (p=0.05) in the three sampling zones. Exposure levels were similar in all three test zones.

The following issues of potential concern were identified:

- The following field fortification issues are noted:
 - The field fortification spike samples were not connected to air sampling pumps and as such were not exposed to the same conditions as the field samples. They should have been exposed to the same air flow for the same duration as the field samples.

- Field fortifications were conducted on only one study day throughout the 182 day monitoring period.
 - Only two samples were fortified per fortification level.
 - The fortification levels selected did not bracket the residues. A fortification level at the LOQ (1.5 µg) would have been more appropriate.
 - A low recovery of 52.0% was observed at the high fortification level. The study author attributed this to contact and drying of the fortification solvent onto the glass tube during the fortification step. The recoveries at the high fortification level were not used to correct the field residues because the low fortification level was closer to the field residues levels detected.
- Protocol amendments and deviations were not provided.
 - The 15-min exposure duration for the samples collected within the first 24 hours after application may not have been of sufficient duration to result in reasonable detection (all samples were <LOQ). The samples were collected using an airflow rate of 0.2 L/min, resulting in a sample volume of 3 L. The study stated that a 0.2 L/min airflow rate was used as recommended in OSHA Method 35. However, OSHA Method 35 also recommends an air volume of 10 L, which would mean the sample duration should have been 50 minutes using a 0.2 L/min airflow rate.
 - The raw residue data was not presented. Results were already converted to air equivalent concentration units (mg/m³) calculated using the airflow rate, minutes of exposure and residue found in each tube.
 - The raw residue data were not corrected for field fortification recoveries.
 - Airflow rates were recorded, however, it is uncertain if airflow rates were recorded at the initiation and termination of the monitoring period.
 - In the breakthrough study, recovery was 77.1% and 92%. The Study Authors noted that variance from complete mass balance was most likely due to adsorptive losses of analyte to the connection tubing within the sampling train.

COMPLIANCE: Signed and dated GLP, Quality Assurance, and Data Confidentiality statements were not provided with this study.

CONCURRENT DISLODGEABLE RESIDUE DISSIPATION STUDY?: No

GUIDELINE OR PROTOCOL FOLLOWED:

The Registrant followed Landis Protocol Number 29821A003.

The study was reviewed based on the applicable sections of the following EPA study guidelines: OPPTS Series 875, Occupational and Residential Exposure Test Guidelines, Group A/B Applicator/Postapplication Exposure Test Guidelines; 875.1000, 875.2500, and 875.2900.

I. MATERIALS AND METHODS

A. MATERIALS

1. Test Material:

Formulation:	ENOZ® Old Fashioned Moth Balls, containing a nominal 99.95% naphthalene. Naphthalene content was 101 ± 1.0 wt% at test initiation and dropped only slightly to 97.3 ± 0.12 wt% over the duration of the exposure period (182 days).
Lot/Batch # technical:	451-68A
Lot/Batch # formulation:	MFG11510C
Purity:	The purity of the reference substance was 99.5% (expiration date September 2015)
CAS #(s):	91-20-3
Other Relevant Information:	EPA Reg. No. 1475-74

2. Relevance of Test Material to Proposed Formulation(s):

Information on the test product was not provided in this study.

B. STUDY DESIGN

The Registrant followed Landis Protocol Number 29821A003. The study stated that deviations were documented in the raw data and that no field event had a detrimental effect on the quality or integrity of the study; however, the study did not provide the actual deviations. No amendments to the protocol were reported.

1. Site Description

Test locations: The tests were carried out at two uninhabited residences (treated and non-treated) located in Lowndes County, GA. Both of the residences were reported as typical for housing in this region. Application took place on March 21, 2011 and sampling took place over the next 182 days.

The test product was placed in a closet and in a dresser drawer in a bedroom at the treated residence (refer to Figure 1). Each site was set up in a similar manner, with only one entrance to the bedroom and a single closet that only opened into the subject bedroom. Additionally, the bedrooms only contained one bed and one set of dresser drawers.

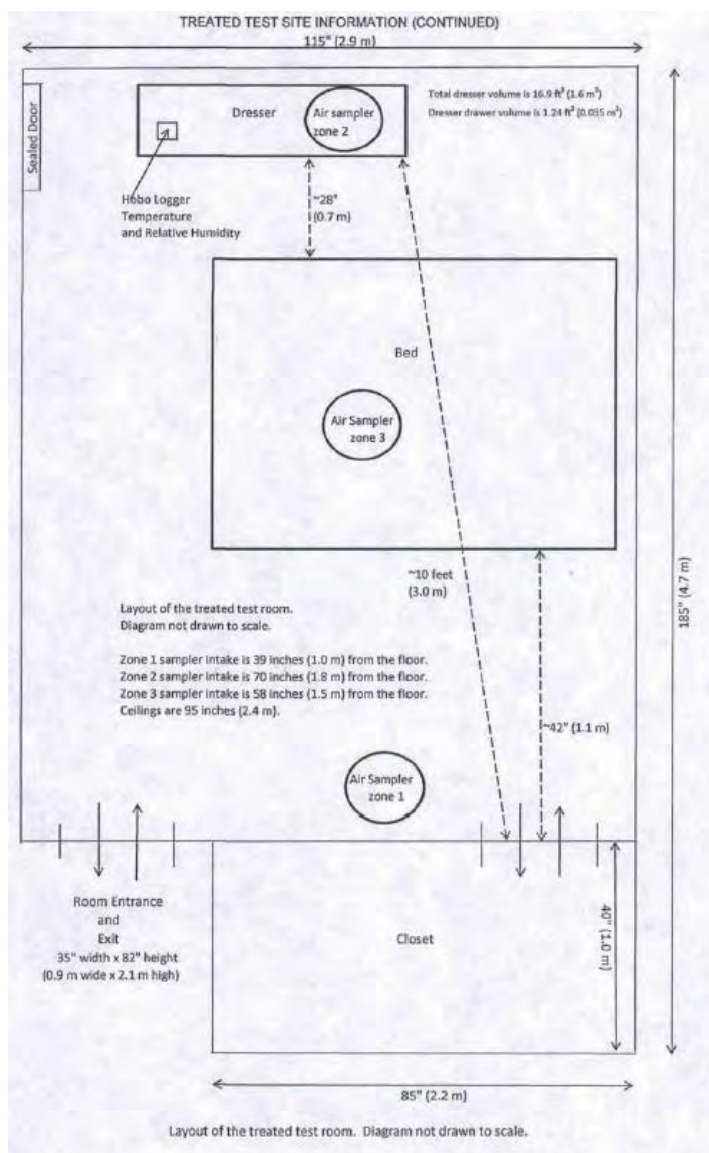


Figure 1. Layout of the Treated Room

Meteorological Data: Temperature was controlled at each site by central heating and air conditioning units. Hourly temperature and relative humidity were recorded by Hobo® data loggers. In the treated residence, air temperature ranged from 18.3 to 26.6°C and average weekly relative humidity ranged from 61.3 to 71.4%. Airflow was checked every two months to ensure that the air changes remained within the 3-5

ACH range stated in the study protocol. Measured air changes ranged from 2.6 to 4.7 air changes per hour.

2. Application Rates and Regimes

Application rate(s): The product was applied at a rate of 1 oz per 3 ft³, the labeled application rate. The amount of test material applied was 62.24 oz (1764.5 g) to the closet, based on a closet volume of 186.725 ft³ and 0.41 oz (11.6 g) to the dresser drawer, based on a drawer volume of 1.24 ft³.

Application Regime: The test product was weighed on an electronic analytical balance and placed in containers for transport to the treated site. At the treated site, the applicator placed the mothballs loosely in the dresser drawer and in the closet, inside of an open container. The closet door and dresser drawer were closed. The applicator then exited the room and closed the door.

Application Equipment: The test product was applied by hand, with the applicator wearing a respirator and gloves.

Equipment Calibration Procedures: The amount of test product applied was weighed using an electronic analytical balance which was checked with certified weights that bracketed the amount of test material to be weighed.

3. Air Sampling Procedures

Sampling Method and Equipment: Air samples in both the treated and non-treated rooms were collected from fixed positions using Chromosorb 106 sorbent tubes attached to an Air Check 2000 air sampler (SKC, Inc.) with a constant air flow of 0.2 L/min. According to the study, an airflow rate of 0.2 L/min was selected based on OSHA Method 35 which recommends an air volume of 10 L and a 0.2 L/min flow rate.
(<http://www.osha.gov/dts/sltc/methods/organic/org035/org035.html>).

Samples were collected from three fixed positions in the treated room, including outside the closet (Zone 1; intake 39 inches from floor), on the dresser (Zone 2; intake 70 inches from the floor), and on the bed (Zone 3; intake 58 inches from the floor). In the non-treated room, samples were only collected from the bed. Prior to sampling, the closet door was opened and closed once, and the dresser drawer containing the loose mothballs was opened and closed once. This step acted as a check to determine if the product had sublimated and to simulate the worst-case homeowner exposure setting.

Replicates:

- Replicates per sampling interval: Single samples were collected from each sampling location during each sampling interval.
- Number of sampling intervals: Seven 15-minute samples were collected at the following intervals: 1 hr prior to application and at 1, 4, 8, 12, 16, and 24 hours after application.

Thirty-seven 8-hour samples were collected at the following intervals: daily between Day 2 and Day 14 after application and once weekly thereafter over the 182 day study period.

4. Sample Handling and Storage

After sampling, each tube was removed from the sampler, capped, and placed in an appropriately labeled bag and within 2 hours was stored in a refrigerator (0.9 to 7.4°C) until shipment to the analytical laboratory (up to 36 days). All inhalation exposure samples were shipped in coolers (separate coolers for non-treated and treated samples) with ice packs via FedEx Priority Overnight to Wildlife International, Ltd., and the samples were received in good condition and cool. The samples were kept cool or refrigerated ($4.89 \pm 0.99^{\circ}\text{C}$) until analysis. Samples were stored refrigerated for 7 to 43 days prior to extraction for analysis.

5. Analytical Methodology

Extraction methods: The sorbent was extracted with one milliliter of carbon disulfide, fortified with 25.0 ug/mL 1-phenylhexane which served as the internal standard (IS). The vials were sealed and vortexed for 30 minutes to completely desorb trapped naphthalene residues from the sorbent media. The extracts were analyzed using a gas chromatograph equipped with a flame ionization detector (GC-FID).

Detection methods: See Table 1.

Table 1. Summary of GC/FID Chromatographic Conditions	
GC Column	Restek Rxi-lms; 30 m x 0.53 mm, 1.5 μm film thickness
Carrier Gas	Helium, nominal initial pressure = 6.09 psi (7.6 mL/min)
Temperatures	Detector: 250 °C Injector: 200 °C
Oven Program	Initial: 75° C, hold for 1 min Ramp A: 20° C /min to 130° C, hold for 4 min. Ramp B: 30° C /min to 280° C, hold for 1 min.
MITC Retention Time	Naphthalene: 6.93-6.94 min. 1-Phenylhexane (IS): 8.53 - 8.54 min
Injection Volume	2 μL

Method validation: Wildlife International, Ltd., Easton, MD, conducted the analytical portion of the study in accordance with Protocol Amendment Number 1A to Landis International, Inc. Protocol Number 29821A003.

Breakthrough testing was performed at the laboratory using Chromosorb 106 sorbent tubes. Duplicate sampling trains were prepared, consisting of glass tubes packed with glass wool connected in a series with two identical sorbent tubes (primary and breakthrough). An air pump was connected to the break-through sorbent tube and was calibrated before use to deliver 0.2 L/min. The glass wool was fortified with 25 µg naphthalene. Following an 8-hr exposure time naphthalene was not detected in either the dosing or break-through tubes (LOD = 0.207 µg/tube). In the collection tubes, naphthalene was 19.3 and 23.0 µg (77.1% and 92% of nominal fortified amounts). The study noted that variance from complete mass balance was most likely due to adsorptive losses of analyte to the connection tubing within the sampling train.

Instrument performance and calibration: Calibration curves were generated for each analytical sequence. The entire suite of naphthalene calibration standards (at least 5) was injected at the beginning and end of each analytical sequence. A calibration standard was also injected following a minimum of five sample injections. It should be noted that some field sample residues were extrapolated because the residues were above the LOQ (1.5 µg), but below the low-level calibration standard at the time of analysis.

Quantification: Peak area response ratios for naphthalene to 1-phenylhexane (ordinate) were plotted against the ratio of their respective known naphthalene to 1-phenylhexane concentration ratios (abscissa). A regression equation of the naphthalene to 1-phenylhexane concentration ratio versus response ratio for the calibration standards was then fitted to the calibration standard data. The concentration of naphthalene in samples was determined by substituting the respective detector response ratio for the sample into the regression equation.

The LOQ, defined as the LLMV, was 1.50 µg, which is equivalent to 0.500 mg/m³ for a fifteen-minute exposure and 0.0156 mg/m³ for an 8-hour exposure at an airflow rate of 0.2 L/min. The LOD was 0.207 µg, which is equivalent to 0.0217 mg/m³ for a fifteen-minute exposure and 0.00215 mg/m³ for an 8-hour exposure at an airflow rate of 0.2 L/min.

6. Quality Control

Lab recovery: Two procedural recovery samples were prepared and analyzed concurrently with each processed sample set. The low-level samples were fortified with naphthalene at 10 µg or 1.5 µg and the high-level samples were fortified at 25

µg. Average recoveries were 94.3 ± 1.76 at 1.5 µg (n=4), 94.9 ± 1.10 at 10 µg (n=5), and 93.3 ± 1.84 at 25 µg (n=9). Residues were less than the LOQ in all laboratory blank samples.

Field blanks: One field blank sample was prepared, which consisted of one tube fortified with 25 uL of the xylene cleaning solution. The naphthalene level was less than the LOQ in the field blank.

Field recovery: Chromosorb 106 sorbent tubes were fortified in duplicate with naphthalene at the test site for two fortification levels (10 and 25 µg). The tubes were fortified, allowed to air dry for one hour and were then capped, placed in plastic storage bags and placed in refrigerated storage. They were not connected to air sampling pumps and were not subjected to the same air flow for the same duration as the field samples. Samples were fortified on March 17, 2011 and analyzed on April 5, 2011 (19 day storage interval). All field fortification samples were shipped to the analytical laboratory under the same conditions as used to transport the field samples. The field fortification samples were processed in an identical manner as described for the field collected air samples.

Results are shown in Table 2. At the 10 µg level (n=2), recoveries were 86.3% and 93.7%, with an average recovery of 90%. At the 25 µg level (n=2), recoveries were 52.0% and 87.6%, with an average recovery of 79.9%. According to the study report, the low recovery of 52.0% is most likely attributed to contact and drying of the fortification solvent onto the glass tube during the fortification step (the analyte adsorbed to the glass was not extracted using the OSHA method). Overall, the average recovery was $79.9 \pm 18.9\%$ with the low recovery value and $89.2 \pm 4.0\%$ if you exclude the low recovery value.

Table 2. Summary of Naphthalene Field Fortification Recoveries				
Field Fortification Level (µg)	n	Percent Recovery	Average	Standard Deviation
10	2	86.3, 93.7	90.0	NA
25	2	52.0, 87.6	69.8	NA
Overall	4	52.0-93.7	79.9	18.9

NOTE: These samples were not attached to air sampling pumps and subjected to the same air flow rate for the same duration as the field samples.

Formulation: The test product was ENOZ® Old Fashioned Moth Balls, containing a nominal 99.95% naphthalene. The naphthalene content in product samples (beginning of

study) and test material samples (at the end of the sampling period) were confirmed. The mean naphthalene content was $101 \pm 1.0\%$ at the initiation of the study and dropped slightly to $97.3 \pm 0.12\%$ over the duration of the exposure period. The study stated that the weight difference from the beginning and end of the exposure period may be due to moisture adsorption.

Tank mix: Not applicable

Travel Spikes: Field fortification samples were used to assure stability of naphthalene upon collection and shipment of field-collected samples (refer to Table 2 above).

Storage Stability: Storage stability samples were prepared in Chromosorb 106 sorbent tubes and analyzed on Day 0, Day 30 and Day 61. Each interval consisted of one blank (fortified with solvent only) and duplicate stored tubes which were fortified with naphthalene at $25 \mu\text{g}/\text{sample}$. Stored samples were placed in a refrigerator until analysis. Mean recoveries were 102% and 98% of the Day 0 values following 30 and 61 days of refrigerated storage, respectively.

II. RESULTS AND CALCULATIONS:

For the treated residence, Table 3 provides the uncorrected air concentration results in mg/m^3 , as calculated by the study author, and air concentration results corrected for field fortification, as calculated by Versar. Air concentrations were corrected by Versar using the average recovery from the low level field fortification, which was the level that most closely corresponded to the field residues. In all calculations Versar used $\frac{1}{2}$ LOD, or $\frac{1}{2}$ LOQ if the concentration was below the LOD or between the LOD and LOQ, respectively.

Table 4 provides a summary of the corrected air concentrations in the treated residence. All naphthalene residues were $<\text{LOQ}$ ($1.5 \mu\text{g}$ or $0.50 \text{ mg}/\text{m}^3$) or $<\text{LOD}$ ($0.207 \mu\text{g}$ or $0.0217 \text{ mg}/\text{m}^3$) in the 15-min samples collected over six intervals from 1 hour to 24 hours after application. For the 8-hr samples collected 2 days through 182 days after application, naphthalene air concentrations ranged from 0.0011 ($<\text{LOD}$) to $0.0574 \text{ mg}/\text{m}^3$ (average of $0.0369 \text{ mg}/\text{m}^3$) in all Zones. Specifically, air concentrations were 0.0011 ($<\text{LOD}$) to $0.0471 \text{ mg}/\text{m}^3$ (average of $0.0360 \text{ mg}/\text{m}^3$) in Zone 1 (outside closet door), 0.0078 ($<\text{LOQ}$) to $0.0574 \text{ mg}/\text{m}^3$ (average of $0.0386 \text{ mg}/\text{m}^3$) in Zone 2 (on top of the dresser), and 0.0210 to $0.0459 \text{ mg}/\text{m}^3$ (average of $0.0362 \text{ mg}/\text{m}^3$) in Zone 3 (on the bed).

In general, residues stabilized within 2 days after the application and remained relatively stable throughout the monitoring period. The study author conducted a regression analysis which showed a significant positive correlation between time and naphthalene concentration in Zones 1 and 3. In Zone 2, this correlation was not observed, but according to the study author a small correlation could have been masked by sample variability. The study author also conducted analysis of variance (ANOVA) testing which indicated that there were no significant differences ($P=0.05$) in the three sampling zones. Exposure levels were similar in all three test zones.

In the non-treated residence, residues were <LOD in all 15-minute samples collected from the bed and <LOD or <LOQ from all 8-hr samples collected from the bed.

III DISCUSSION

A. LIMITATIONS OF THE STUDY:

This study met most of the applicable EPA study guidelines. The following issues of potential concern were identified:

The following issues of potential concern were identified:

- The following field fortification issues are noted:
 - The field fortification spike samples were not connected to air sampling pumps and as such were not exposed to the same conditions as the field samples. They should have been exposed to the same airflow for the same duration as the field samples.
 - Field fortifications were conducted on only one study day throughout the 182 day monitoring period.
 - Only two samples were fortified per fortification level.
 - The fortification levels selected did not bracket the residues. A fortification level at the LOQ (1.5 µg) would have been more appropriate.
 - A low recovery of 52.0% was observed at the high fortification level. The study author attributed this to contact and drying of the fortification solvent onto the glass tube during the fortification step. The recoveries at the high fortification level were not used to correct the field residues because the low fortification level was closer to the field residues levels detected.
- Protocol amendments and deviations were not provided.
- The 15-min exposure duration for the samples collected within the first 24 hours after application may not have been of sufficient duration to result in reasonable detection (all samples were <LOQ). The samples were collected using an airflow rate of 0.2 L/min, resulting in a sample volume of 3 L. The study stated that a 0.2 L/min airflow rate was used as recommended in OSHA Method 35. However, OSHA Method 35 also recommends an air volume of 10 L, which would mean the sample duration should have been 50 minutes using a 0.2 L/min airflow rate.
- The raw residue data was not presented. Results were already converted to air equivalent concentration units (mg/m³) calculated using the airflow rate, minutes of exposure and residue found in each tube.
- The raw residue data were not corrected for field fortification recoveries.
- Airflow rates were recorded, however, it is uncertain if airflow rates were recorded at the initiation and termination of the monitoring period.

- In the breakthrough study, recovery was 77.1% and 92%. The Study Authors noted that variance from complete mass balance was most likely due to adsorptive losses of analyte to the connection tubing within the sampling train.

B. CONCLUSIONS:

Naphthalene was monitored in indoor air of a residential building for 182 days after application of the test product (ENOZ® Old Fashioned Moth Balls) to a closet and a dresser drawer in a bedroom of the residence. The maximum air concentration observed was 0.0574 mg/m³. Air concentrations stabilized by the second day after application and remained relatively stable throughout the monitoring period. No significant differences were observed between the residues from the three sampling zones within the bedroom.

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence

Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
-1 hr	1	15	0.20	ND	0.011
	2	15	0.20	ND	0.011
	3	15	0.20	ND	0.011
1 hr	1	15	0.20	<LOQ	0.25
	2	15	0.20	<LOQ	0.25
	3	15	0.20	<LOQ	0.25
4 hr	1	15	0.20	<LOQ	0.25
	2	15	0.20	<LOQ	0.25
	3	15	0.20	<LOQ	0.25
8 hr	1	15	0.20	<LOQ	0.25
	2	15	0.20	ND	0.011
	3	15	0.20	<LOQ	0.25
12 hr	1	15	0.20	<LOQ	0.25
	2	15	0.20	<LOQ	0.25
	3	15	0.20	<LOQ	0.25
16 hr	1	15	0.20	ND	0.011
	2	15	0.20	<LOQ	0.25
	3	15	0.20	<LOQ	0.25
24 hr	1	15	0.20	<LOQ	0.25
	2	15	0.20	<LOQ	0.25
	3	15	0.20	<LOQ	0.25
2	1	480	0.20	0.0229 ^d	0.0254
	2	480	0.20	0.0305	0.0339
	3	480	0.20	0.0238 ^d	0.0264
3	1	480	0.20	0.0305	0.0339
	2	480	0.20	0.0517	0.0574
	3	480	0.20	0.0319	0.0354
4	1	480	0.20	0.0304	0.0338
	2	480	0.20	0.0294	0.0327
	3	480	0.20	0.027	0.0300
5	1	480	0.20	0.0279	0.0310
	2	480	0.20	0.0336	0.0373

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence					
Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
	3	480	0.20	0.0289	0.0321
6	1	480	0.20	0.029	0.0322
	2	480	0.20	0.0444	0.0493
	3	480	0.20	0.0369	0.0410
7	1	480	0.20	0.0355	0.0394
	2	480	0.20	0.0434	0.0482
	3	480	0.20	0.0297	0.0330
8	1	480	0.20	0.0317	0.0352
	2	480	0.20	0.0339	0.0377
	3	480	0.20	0.0324	0.0360
9	1	480	0.20	0.038	0.0422
	2	480	0.20	0.0362	0.0402
	3	480	0.20	0.0344	0.0382
10	1	480	0.20	0.0197 ^d	0.0219
	2	480	0.20	0.0399	0.0443
	3	480	0.20	0.0189 ^d	0.0210
11	1	480	0.20	0.029	0.0322
	2	480	0.20	0.0312 ^d	0.0347
	3	480	0.20	0.0304	0.0338
12	1	480	0.20	0.0278 ^d	0.0309
	2	480	0.20	0.0445	0.0494
	3	480	0.20	0.0282	0.0313
13	1	480	0.20	ND	0.0011
	2	480	0.20	0.0335	0.03722
	3	480	0.20	0.0304	0.03378
14	1	480	0.20	0.028	0.03111
	2	480	0.20	0.0241 ^d	0.02678
	3	480	0.20	0.0263	0.02922
21	1	480	0.20	0.0305	0.03389
	2	480	0.20	<LOQ	0.0078
	3	480	0.20	0.0248 ^d	0.0276
28	1	480	0.20	0.0371	0.0412

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence					
Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
	2	480	0.20	0.0396	0.0440
	3	480	0.20	0.0386	0.0429
35	1	480	0.20	0.0314	0.0349
	2	480	0.20	0.0335	0.0372
	3	480	0.20	0.0327	0.0363
42	1	480	0.20	0.0327	0.0363
	2	480	0.20	0.0385	0.0428
	3	480	0.20	0.0301	0.0334

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence					
Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
49	1	480	0.20	0.0354	0.0393
	2	480	0.20	0.0346	0.0384
	3	480	0.20	0.0283	0.0314
56	1	480	0.20	0.0361	0.0401
	2	480	0.20	0.0346	0.0384
	3	480	0.20	0.0295	0.0328
63	1	480	0.20	0.0333	0.0370
	2	480	0.20	0.0318	0.0353
	3	480	0.20	0.0266	0.0296
70	1	480	0.20	0.0344	0.0382
	2	480	0.20	0.038	0.0422
	3	480	0.20	0.0363	0.0403
77	1	480	0.20	0.0346	0.0384
	2	480	0.20	0.0284	0.0316
	3	480	0.20	0.0354	0.0393
84	1	480	0.20	0.0406	0.0451
	2	480	0.20	0.0346	0.0384
	3	480	0.20	0.0413	0.0459
91	1	480	0.20	0.0363	0.0403
	2	480	0.20	0.0416	0.0462
	3	480	0.20	0.0371	0.0412
98	1	480	0.20	0.0414	0.0460
	2	480	0.20	0.0399	0.0443
	3	480	0.20	0.04	0.0444
105	1	480	0.20	0.0405	0.0450
	2	480	0.20	0.0414	0.0460
	3	480	0.20	0.0379	0.0421
112	1	480	0.20	0.0359	0.0399
	2	480	0.20	0.0344	0.0382
	3	480	0.20	0.03	0.0333
119	1	480	0.20	0.04	0.0444
	2	480	0.20	0.0233	0.0259

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence					
Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
	3	480	0.20	0.0353	0.0392
126	1	480	0.20	0.0371	0.0412
	2	480	0.20	0.0391	0.0434
	3	480	0.20	0.041	0.0456

Table 3. Summary of Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence

Days After Application (except as noted)	Zone ^a	Exposure Time (min)	Airflow (L/min)	Naphthalene Air Concentration (mg/m ³) ^b	
				Uncorrected ^c	Corrected ^d
133	1	480	0.20	0.0304	0.0338
	2	480	0.20	0.0354	0.0393
	3	480	0.20	0.036	0.0400
140	1	480	0.20	0.03	0.0333
	2	480	0.20	0.0323	0.0359
	3	480	0.20	0.0412	0.0458
147	1	480	0.20	0.0424	0.0471
	2	480	0.20	0.0239	0.0266
	3	480	0.20	0.02	0.0222
154	1	480	0.20	0.0389	0.0432
	2	480	0.20	0.037	0.0411
	3	480	0.20	0.0374	0.0416
161	1	480	0.20	0.0407	0.0452
	2	480	0.20	0.0291	0.0323
	3	480	0.20	0.0342	0.0380
168	1	480	0.20	0.0295	0.0328
	2	480	0.20	0.0417	0.0463
	3	480	0.20	0.0333	0.0370
175	1	480	0.20	0.0366	0.0407
	2	480	0.20	0.0402	0.0447
	3	480	0.20	0.0378	0.0420
182	1	480	0.20	0.0225	0.0250
	2	480	0.20	0.0303	0.0337
	3	480	0.20	0.0409	0.0454

a. Zone 1 = Outside of the closet; Zone 2 = On the dresser; Zone 3 = On the bed

b. Air concentration (mg/m³) calculated by study author. Air concentration (mg/m³) = residue amount (µg) / (airflow rate (0.20 L/min) * sample duration (15 or 480 min)) * 1 mg/1000 µg * 1000 L/m³.

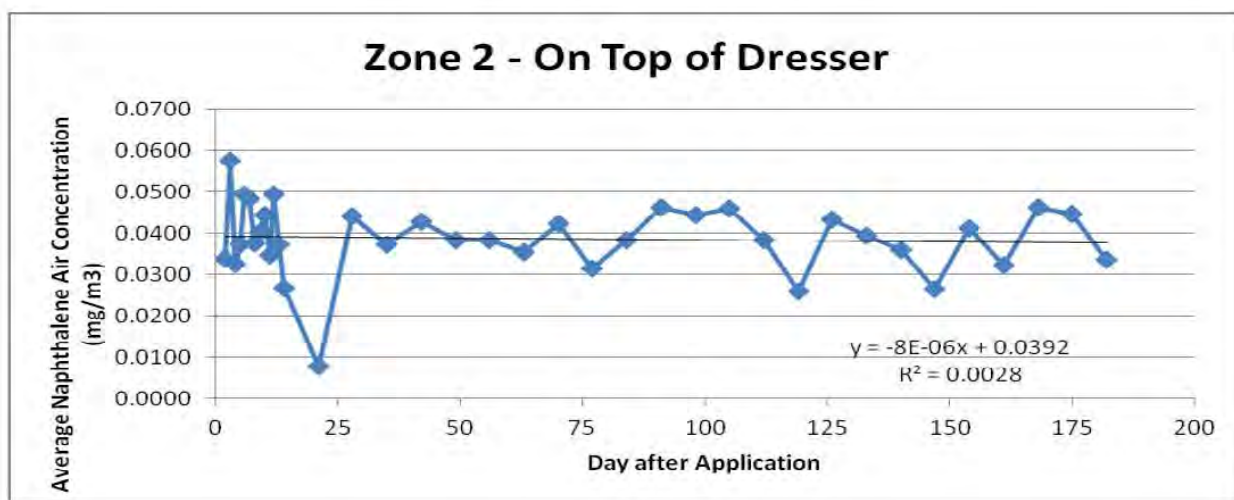
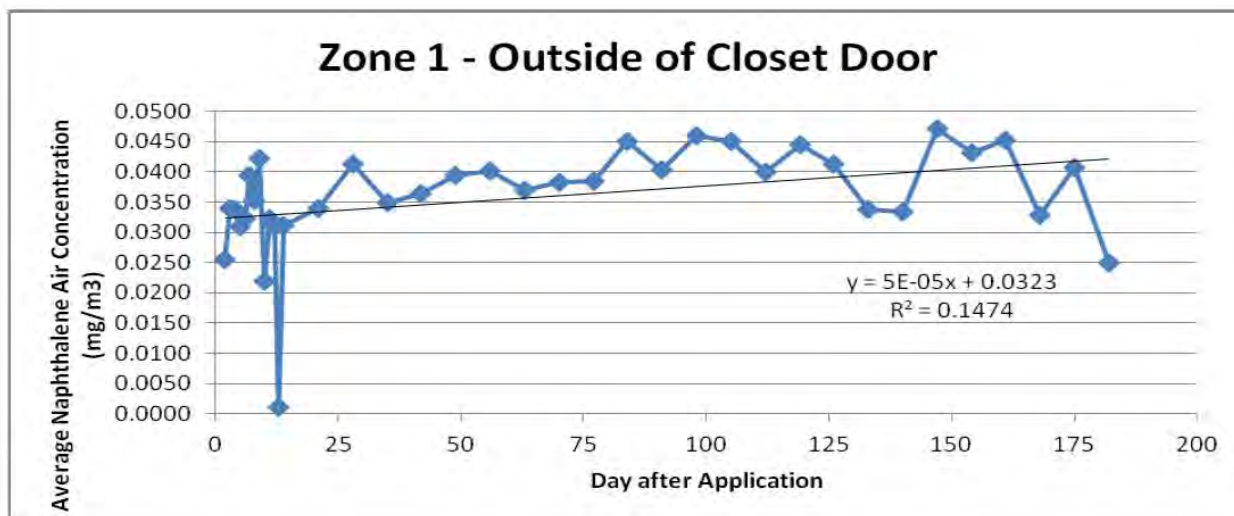
c. ND = not detected at the LOD of 0.00215 mg/m³ for 8-hr samples and 0.0217 mg/m³ for the 15-minute samples. LOQ = 0.0156 mg/m³ for 8-hr samples and 0.50 mg/m³ for the 15-minute samples. For calculation purposes, ½ LOD was used for residues reported as ND and ½ LOQ was used for residues reported between the LOD and LOQ.

d. Air concentrations were corrected by the reviewer using the average low level field fortification recovery of 90% (refer to Table 2). Note that the field fortification spikes are technically transit stability spikes because they were not connected to air pumps at the same rate or for the same time period as the field samples.

e. Values are extrapolated values. Samples were above the LOQ, but below the low-level calibration standard at the time of analysis.

Table 4. Summary of Corrected Naphthalene Indoor Air Concentrations (mg/m³) from the Treated Residence^{a, b}					
Location	n	Minimum	Maximum	Average	Standard Deviation
15-min Exposure Duration Samples (1 to 24 hours after application)					
Zone 1: Outside of the closet	6	ND (0.011)	<LOQ (0.25)	0.2101	0.0976
Zone 2: On the dresser	6	ND (0.011)	<LOQ (0.25)	0.2101	0.0976
Zone 3: On the bed	6	<LOQ (0.25)	<LOQ (0.25)	0.2500	0.0000
Overall	18	ND (0.011)	<LOQ (0.25)	0.2234	0.0773
8-hr Exposure Duration Samples (2 to 182 days after application)					
Zone 1: Outside of the closet	37	ND (0.0011)	0.0471	0.0360	0.0085
Zone 2: On the dresser	37	<LOQ (0.0078)	0.0574	0.0386	0.0086
Zone 3: On the bed	37	0.0210	0.0459	0.0362	0.0065
Overall	111	ND (0.0011)	0.0574	0.0369	0.0079

- a. ND = not detected at the LOD of 0.00215 mg/m³ for 8-hr samples and 0.0217 mg/m³ for the 15-minute samples. LOQ = 0.0156 mg/m³ for 8-hr samples and 0.50 mg/m³ for the 15-minute samples. For calculation purposes, ½ LOD was used for residues reported as ND and ½ LOQ was used for residues reported between the LOD and LOQ.
- b. Air concentrations were corrected by the reviewer for the average low level field fortification recovery of 90% (refer to Table 2).



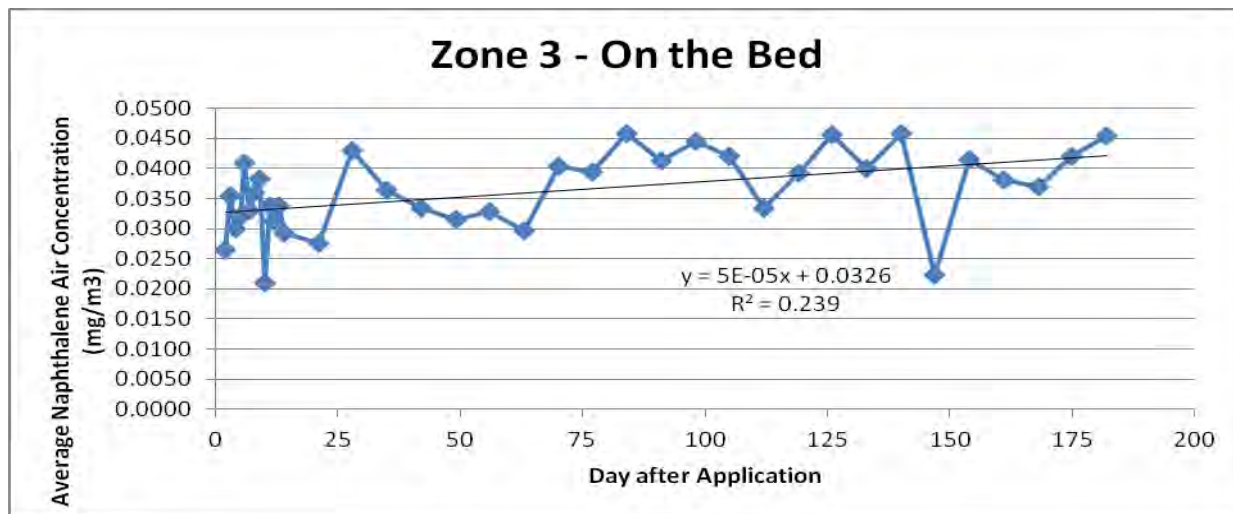


Figure 1. Graphs of air concentration vs. time for three zones in the treated residence

GUIDELINE 875.2500 INHALATION EXPOSURE

- *The test substance must be the typical end use product of the active ingredient.* This criterion was met.
- *The production of metabolites, breakdown products, or the presence of contaminants of potential toxicologic concern, should be considered on a case-by-case basis.* It is uncertain if this criterion was met, metabolites were not discussed.
- *Applications should occur at the time of season that the end-use product is normally applied to achieve intended pest control.* This criterion was met.
- *The end use product should be applied by the application method recommended for the crop. Information that verifies that the application equipment (e.g., sprayer) was properly calibrated should be included.* These criteria were met. The product was weighed on a scale and applied by hand.
- *The application rate used in the study should be provided and should be the maximum rate specified on the label. However, monitoring following application at a typical application rate is more appropriate in certain cases.* This criterion was met.
- *If multiple applications are made, the minimum allowable interval between applications should be used.* This criterion is not applicable. Only one application was made.
- *A sufficient number of replicates should be generated to address the exposure issues associated with each population of interest. In general, the study should include a minimum of 15 replicates per activity, distributed as follows: 5 replicates (i.e., individuals) on each of 3 monitoring periods (i.e., days after application).* This criterion was partially met. Treated samples were only collected from three zones at one site. A total of 44 sampling intervals were monitored.
- *The monitoring period should be of sufficient duration to result in reasonable detectability on dosimeters. Monitoring should be conducted before residues have dissipated beyond the limit of quantification. Baseline samples should be collected before the exposure activity commences.* These criterion were partially met. Baseline samples were collected 1 hour prior to the exposure activity and reasonable detectability was observed in the 8-hr samples. For the 15-minute samples it is uncertain if these criterion were met as residues were less than the LOQ. It should be noted that OSHA Method 35 recommends a sample volume of 10 L using an airflow rate of 0.2 L/min. In this study, an airflow rate of 0.2 L/min was used, which resulted in a sample volume of only 3 L for the 15-minute samples.

- *The selected sites and seasonal timing of monitoring must be appropriate to the activity.* This criterion was met.
- *Studies should be conducted under different geographic/climatologic sites.* This criterion was not met, as only one trial was conducted.
- *Inhalation monitoring techniques area (i.e., stationary) and/or personal monitoring should contain sufficient samples to characterize the likely range of possible exposure concentrations, and to ensure that the reentry scenario can be adequately addressed.* This criterion was met, stationary air monitoring took place in three locations at 44 intervals.
- *Particulate levels should be monitored along with vapor phase concentrations unless adequate justification for not doing so is provided.* It is not certain if this criterion was met.
- *Retention and breakthrough studies should be performed under conditions similar to those anticipated in the field phase of the study.* This criterion was met.
- *The sampling technique used should be appropriate, given the expected exposure scenario (e.g., the use of personal sampling pumps and sampling times consisting of filter cassettes and resin tubes or polyurethane foam filters is preferred; where personal sampling is not appropriate, stationary monitoring may be conducted.) Stationary samples should be collected from the center of treated fields and from at least 4 other locations, preferably at the cardinal compost points from the center location. Indoor sampling strategies should be designed based on the nature of the exposure scenario and building type. Samples should be collected at heights representing the breathing zones of the exposed populations (e.g., 18 inches for children; 48 inches for adults).* These criteria were met.
- *The duration of the sampling interval and air flow rates should be maximized within the appropriate flow rate range to increase the potential for capturing enough residue to be quantifiable.* This criterion was met for the 8-hr samples. It is uncertain if this criterion was met for the 15-minute samples, as only 3 L of air was sampled using a 0.2 L/min airflow rate. According to OSHA Method 35, the recommended sample volume is 10 L using an airflow rate of 0.2 L/min, which would correspond to a 50 minute sampling duration.
- *Air flow rates should be recorded at the initiation and termination of the monitoring period, with the average being used in all calculations.* It is uncertain if this criterion was met.
- *Samples should be stored in a manner that will minimize deterioration and loss of analytes between collection and analyses. Information of storage stability should be provided.* These criteria were met. A storage stability study was conducted.
- *Validated analytical methods of sufficient sensitivity are needed. Information on method efficiency (residue recovery) and limit of quantification (LOQ) should be provided.* These criteria were partially met. It does not appear that a method validation study was conducted prior to the

study. However, concurrent recovery data and LOQs were provided.

- *Information on recovery samples must be included in the study report. A complete set of field recoveries should consist of at least one blank control sample and three or more each of a low-level and high-level fortification. These fortifications should be in the range of anticipated residue levels in the field study.* These criteria were partially met. There were two fortification levels with only two samples per level. The fortification levels were 10 and 25 µg, which would correspond to 0.10 and 0.26 mg/m³ for the 8-hr exposure samples and 3.33 and 8.33 mg/m³ for the 15-min exposure samples (using an airflow rate of 0.2 L/min). The fortification levels did not bracket the field residues (<LOQ for 15-minute exposure samples and <LOQ to 0.0517 mg/m³ for the 8-hr exposure samples). A fortification level at the LOQ (1.5 µg) would have been more appropriate. Also, the field fortification samples were not connected to air sampling pumps with air pumped through them. They were left instead to air dry and were then capped and stored with the field samples.
- *Raw residue data must be corrected if appropriate recovery values are less than 90 percent.* This criterion was not met. The Registrant did not correct the raw residue data for field fortification recoveries.
- *Residues should be reported as µg pesticide active ingredient per sample and as an airborne concentration (µg/m³). Distributional data should be reported, to the extent possible.* These criteria were partially met. The residues were reported as mg/m³ only. The distributional data were reported.